Application of Direct Metal Laser Sintering for Manufacture of Synchrotron Components

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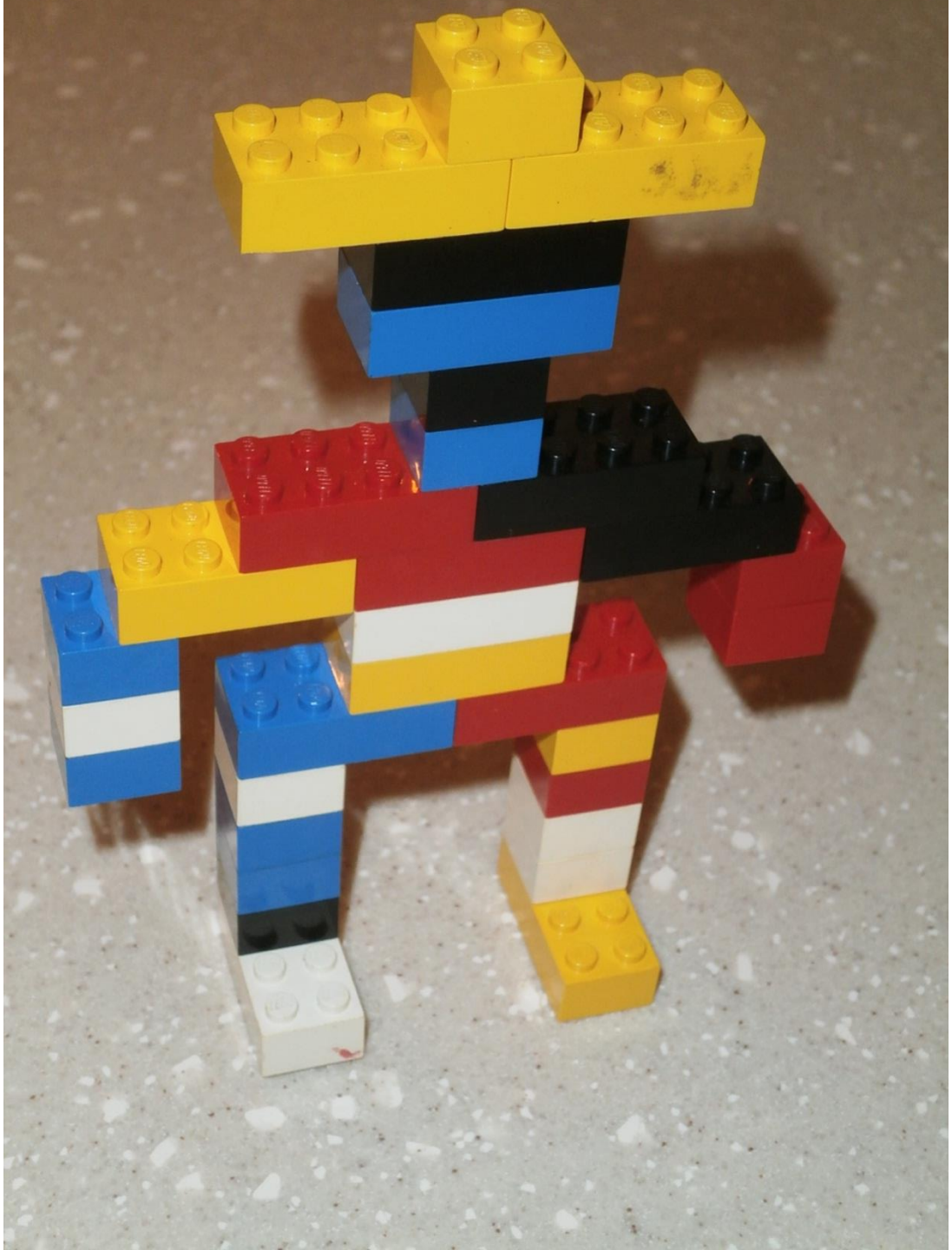
1. What is additive manufacture ?



Additive Manufacture (Metals)

- Electron Beam Melting
- Wire Feed deposition
- Direct Metal Laser sintering

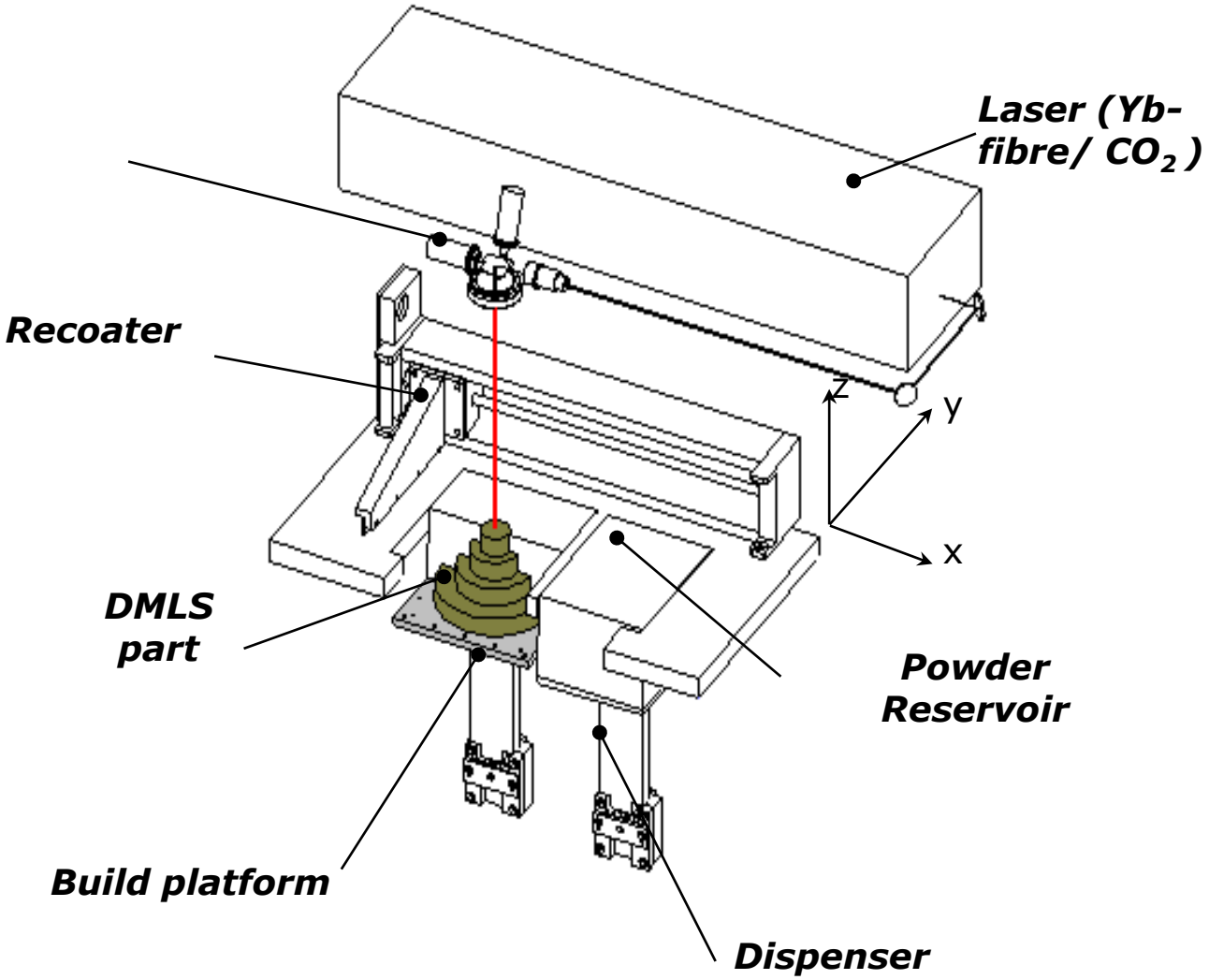
Electron Beam Melting

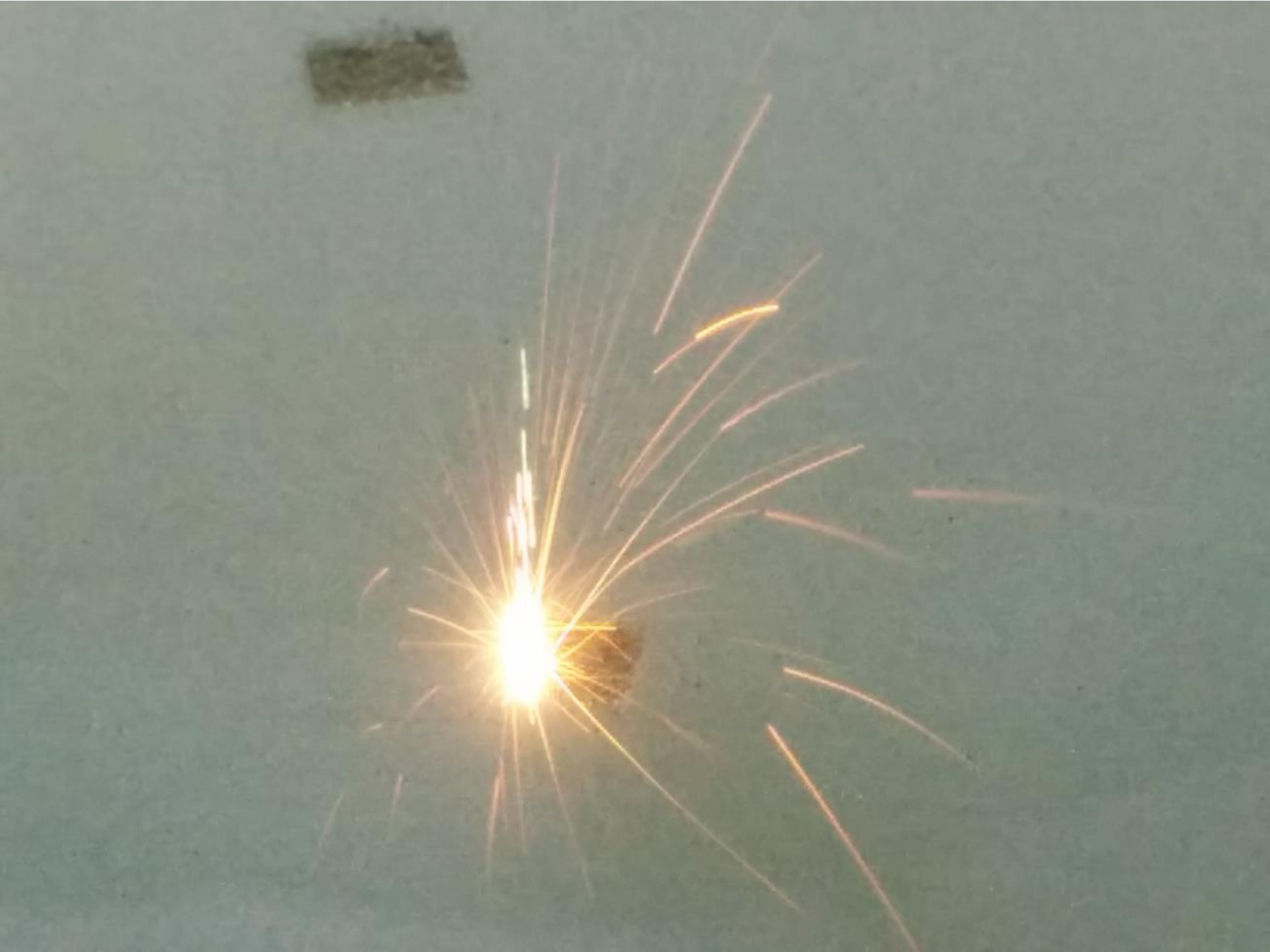
- Arcam EBM
- Vacuum 1 x 10^{-5}mbar
- Hot process – lower residual stress.
- Range of Titanium Alloys

Wire Feed deposition

- Sciaky inc.
- Large structures
- Very high deposition rates

Direct Metal Laser Sintering


Laser (Yb-fibre/ CO_2)
Recoater
z
y
x
DMLS part
Powder Reservoir
Build platform
Dispenser



2. What metals can be used?

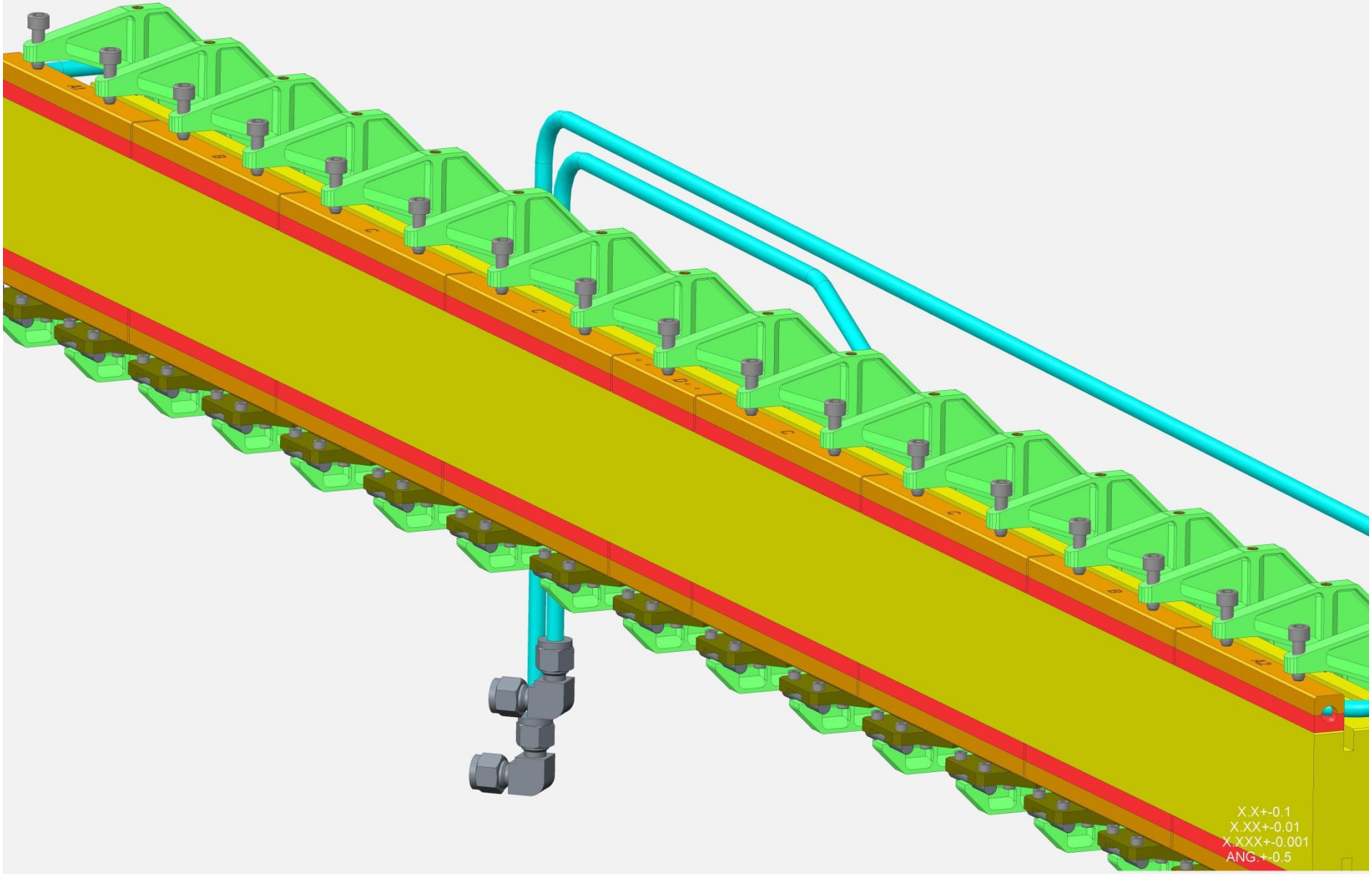
Materials

- Stainless steels (316L, 15-5PH)
- Maraging (1.2709) and Cobalt Chrome Steels (Co28Cr6Mo)
- Cupro Nickel (DM20)
- Titanium Alloys (Ti6Al4V)
- Aluminium Alloys (AlSi10Mg)
- Nickel Alloys (Inconel 718,725, 618)
- Silver alloys (Argentium)
- Copper based alloys

3. What are the advantages?

- Parts direct from CAD
- Complex curves
- Parts can be hollow or have internal lattices
- Rapid Manufacture
- Less waste
- Material only where required
  - Variable wall thickness
  - Integrated cooling channels
  - Highly complex webbing and ribbing
  - Small feature size

4. Is additive manufacture only for prototypes?

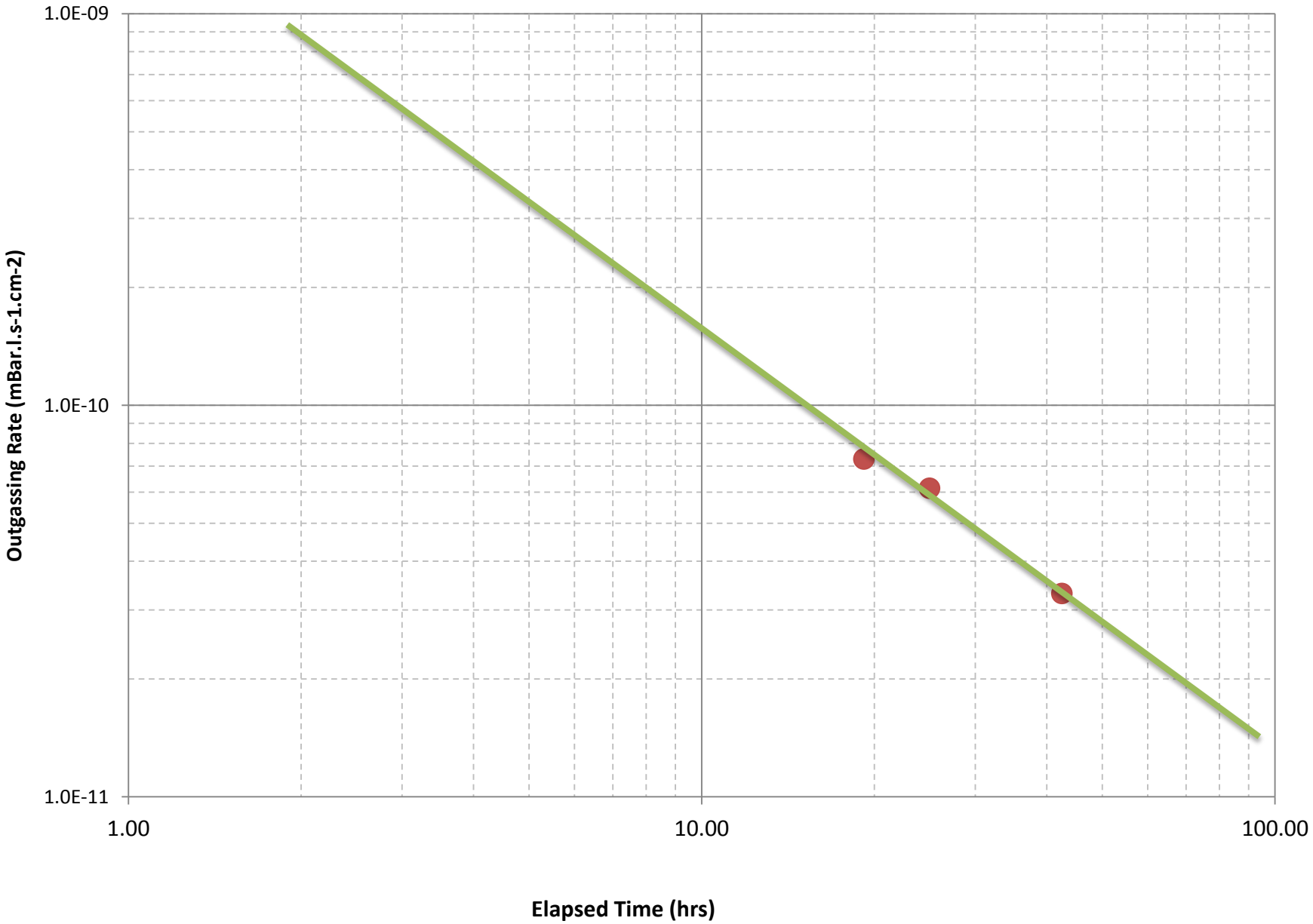

X.X+-0.1
X.XX+-0.01
X.XXX+-0.001
ANG.+-0.5

5. Are metallic parts made by additive manufacture techniques such as laser sintering full of small holes?

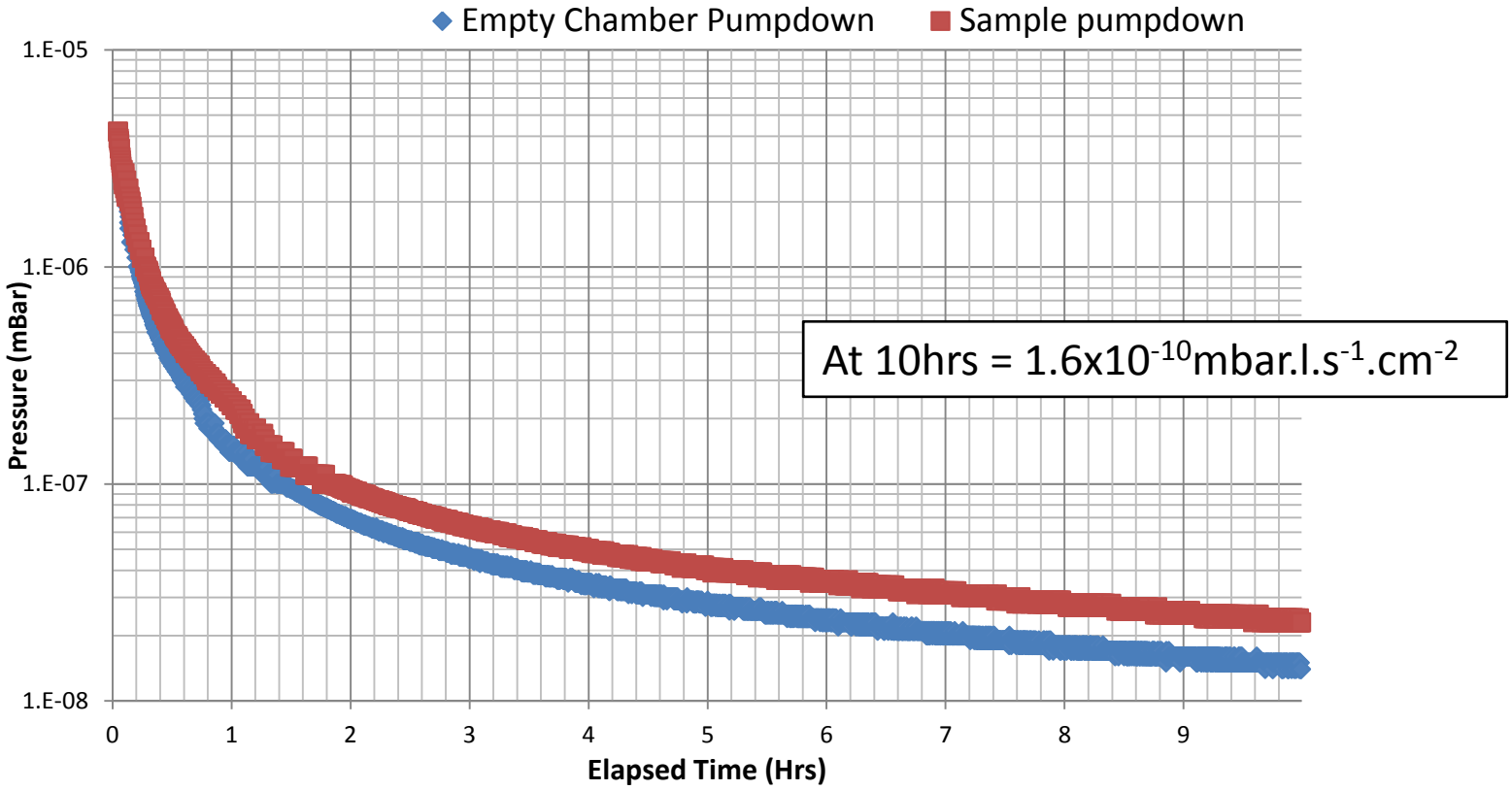
6. Can additive manufactured parts be used for Ultra high vacuum parts?

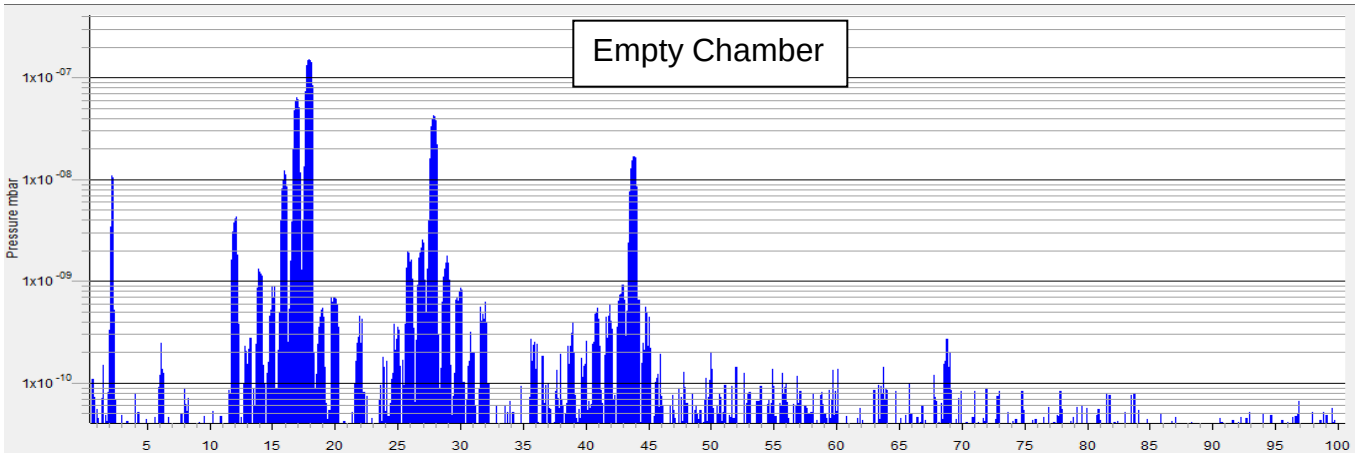

Experiment in Progress
Do not touch

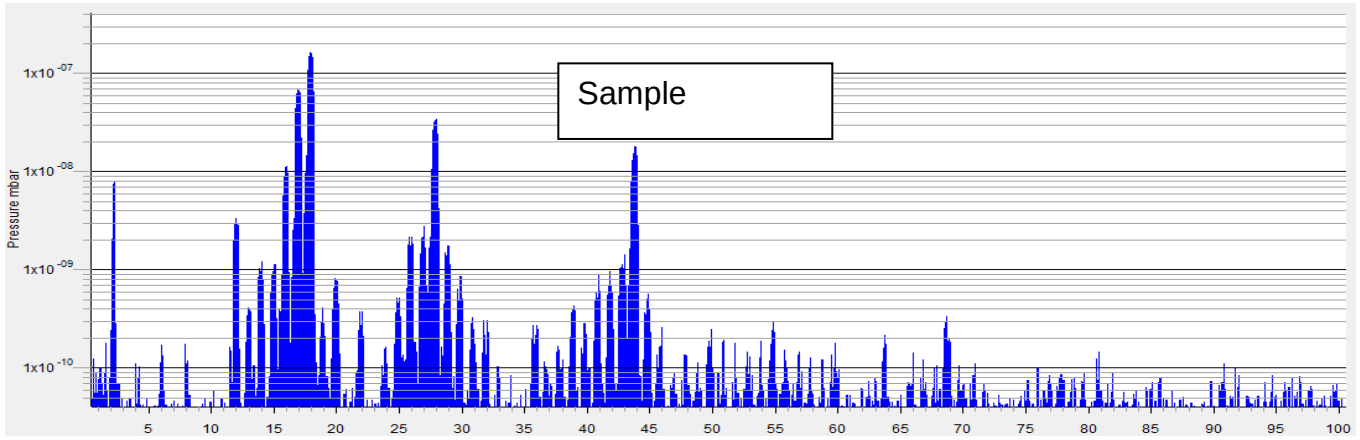
Laser Sintered SS Outgassing Rate

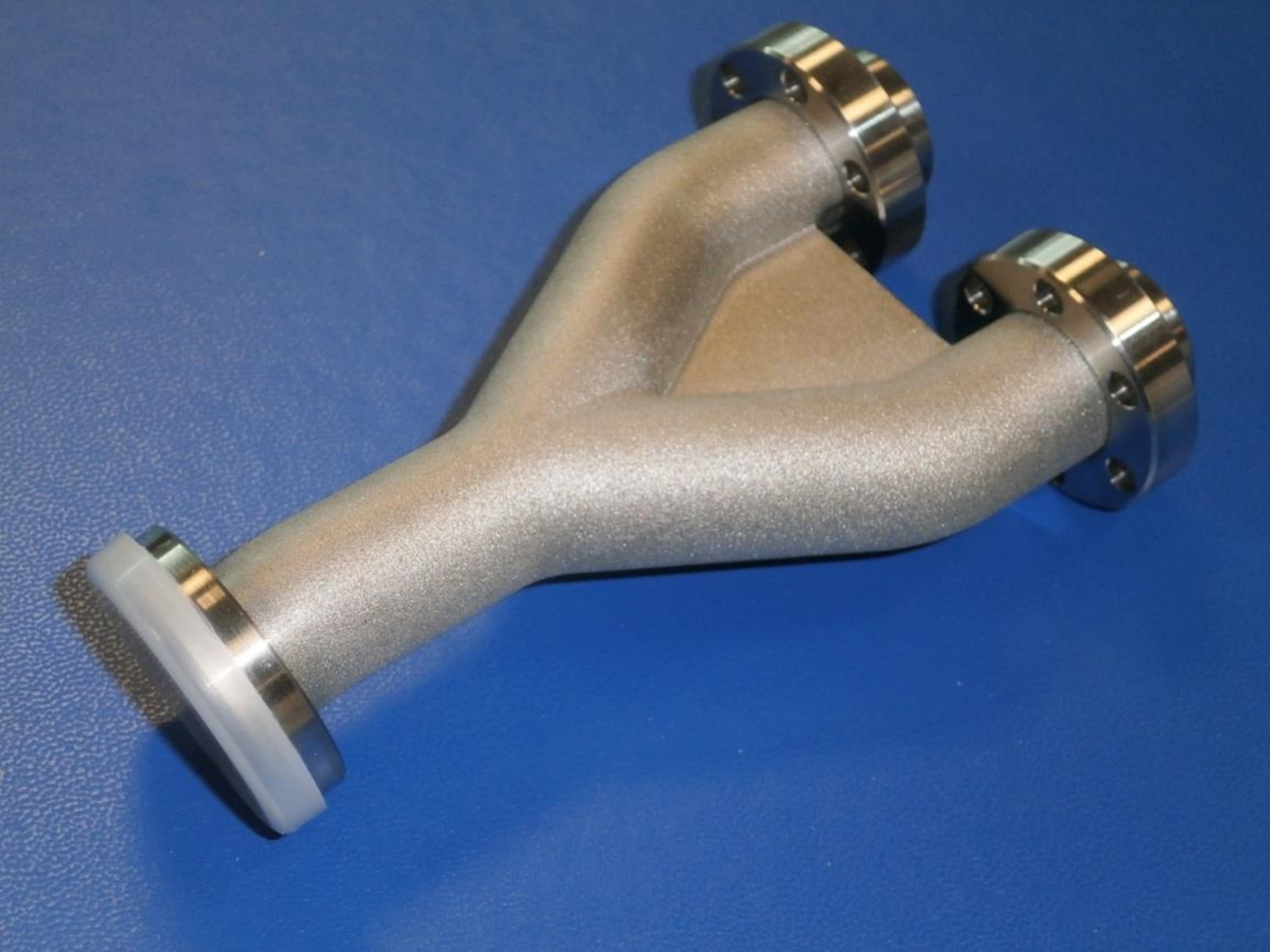


Laser Sintered SS Outgassing Test Pumpdown




Empty Chamber
Pressure mbar
1x10-07
1x10-08
1x10-09
1x10-10
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

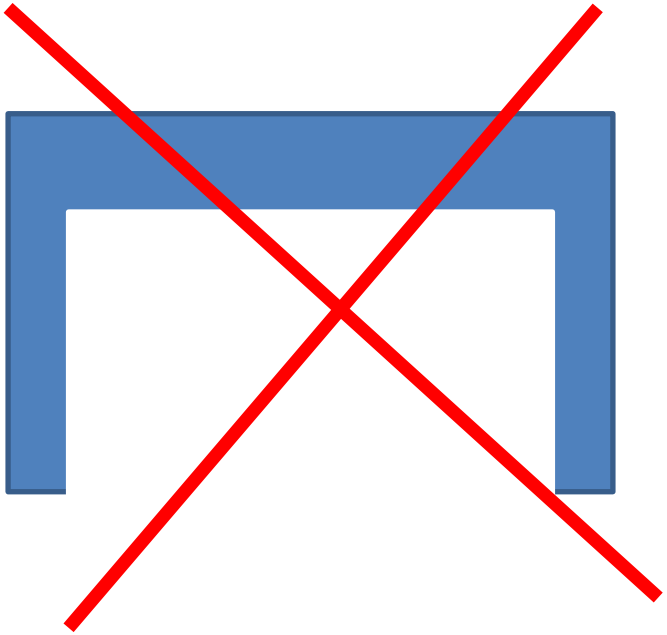

Sample
Pressure mbar
1x10-07
1x10-08
1x10-09
1x10-10
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

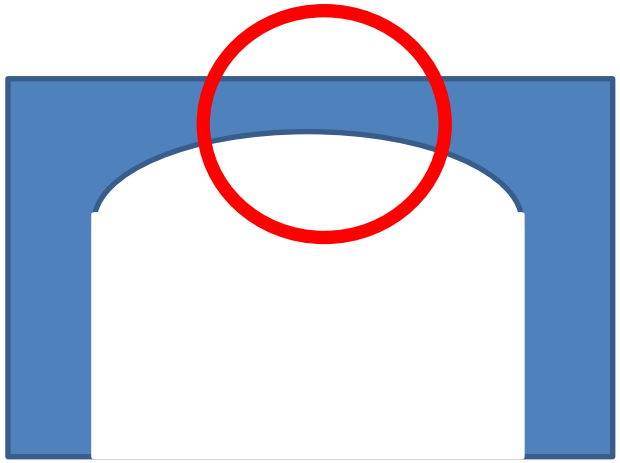


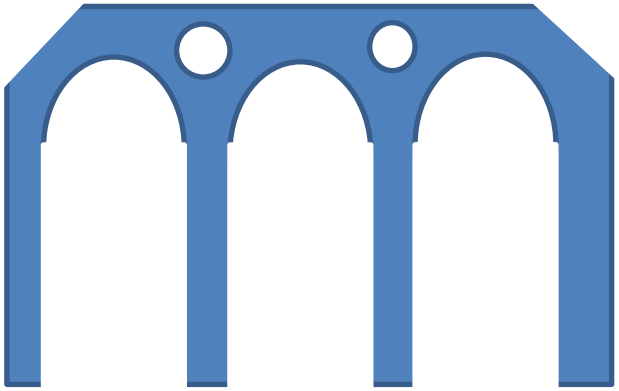
7. Do I need to redesign a part to be manufactured by additive manufacturing?

Material adds cost

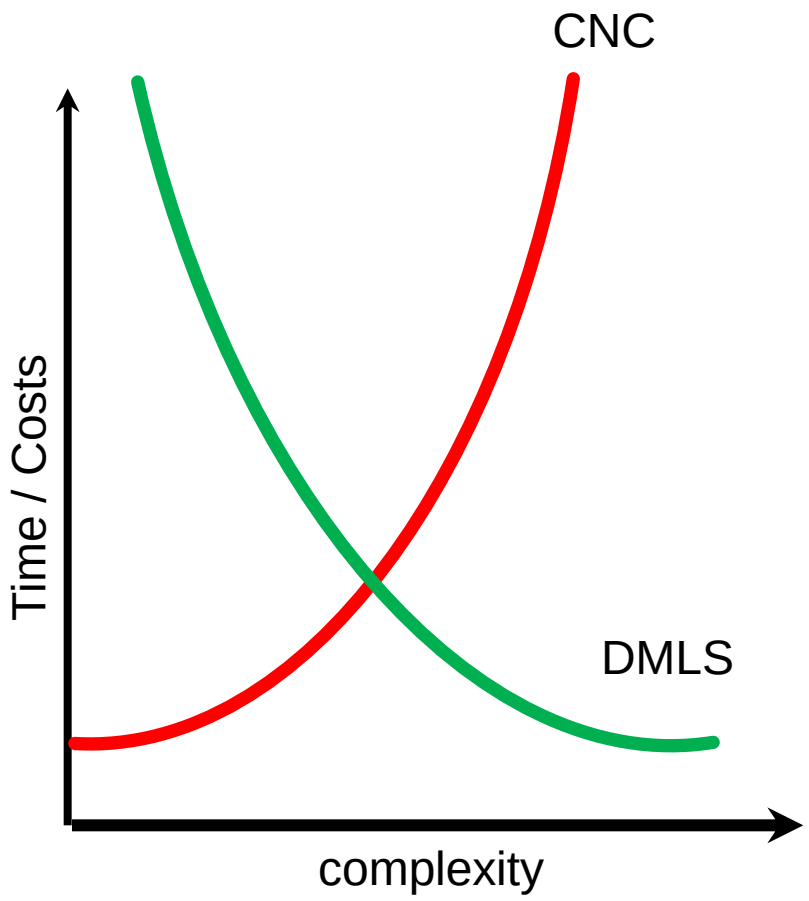
Complexity does not

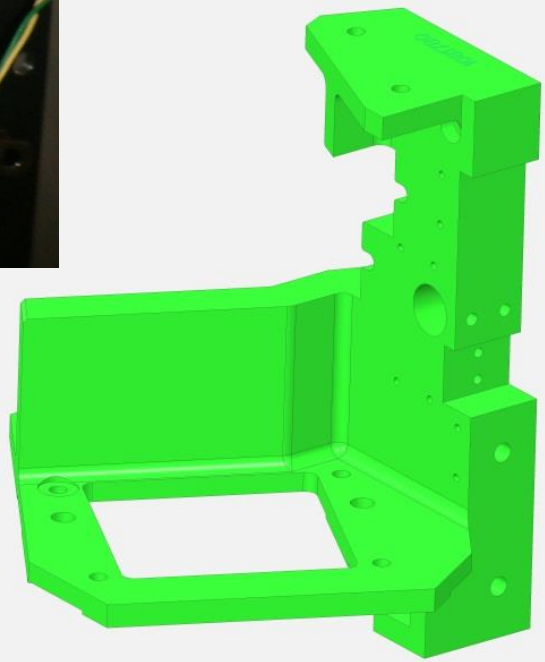






8. Is additive manufacture more expensive than traditional machining?


CNC
DMLS
Time / Costs
complexity



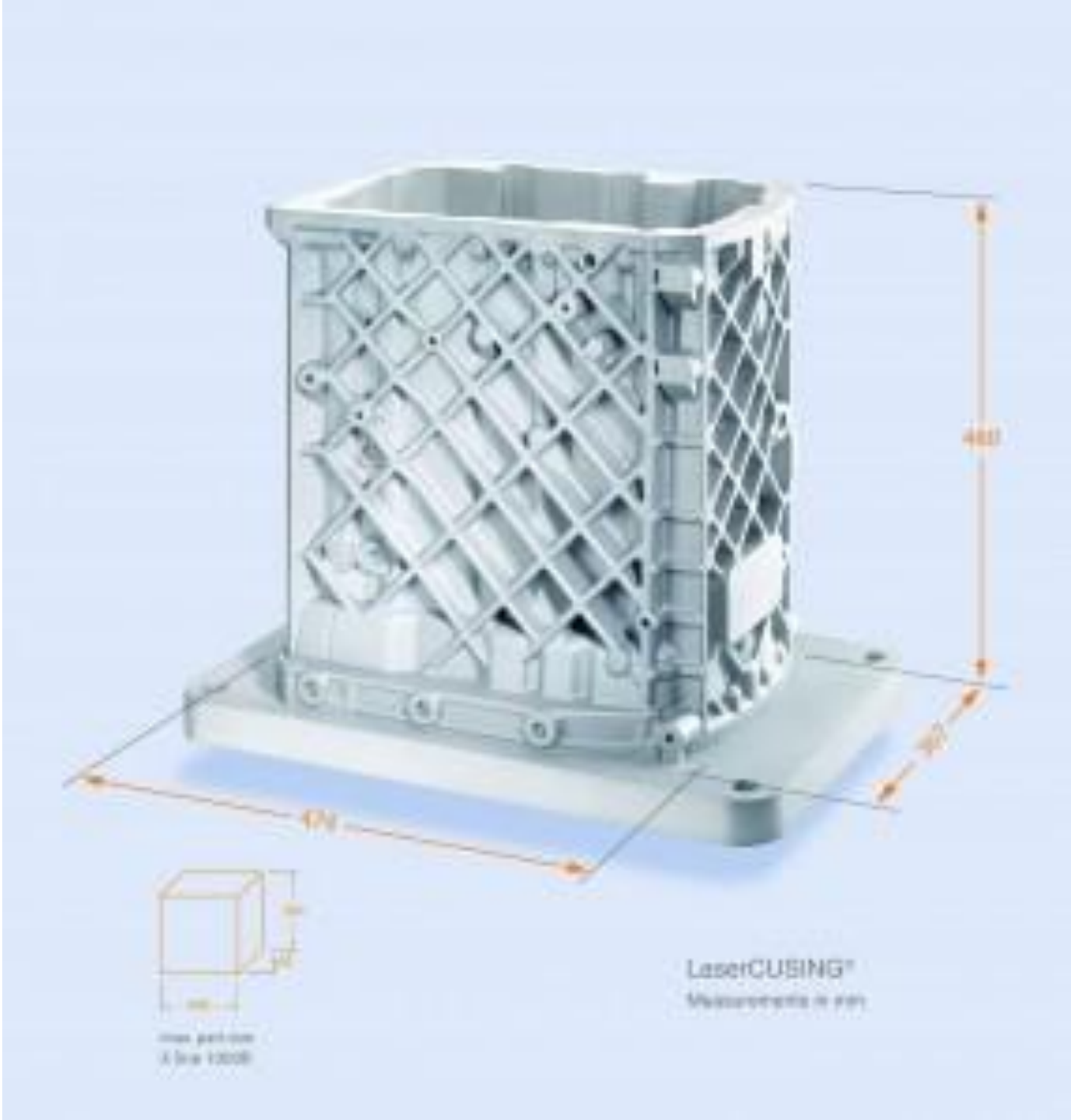
9. What are the smallest features that can be produced ?

- 20µm – 200 µm layers
- 160µm – 180 µm wall thickness
- 20 µm or 5µm powders
- 50 µm hole
- 300 µm between parts

10. Is there a size limitation?

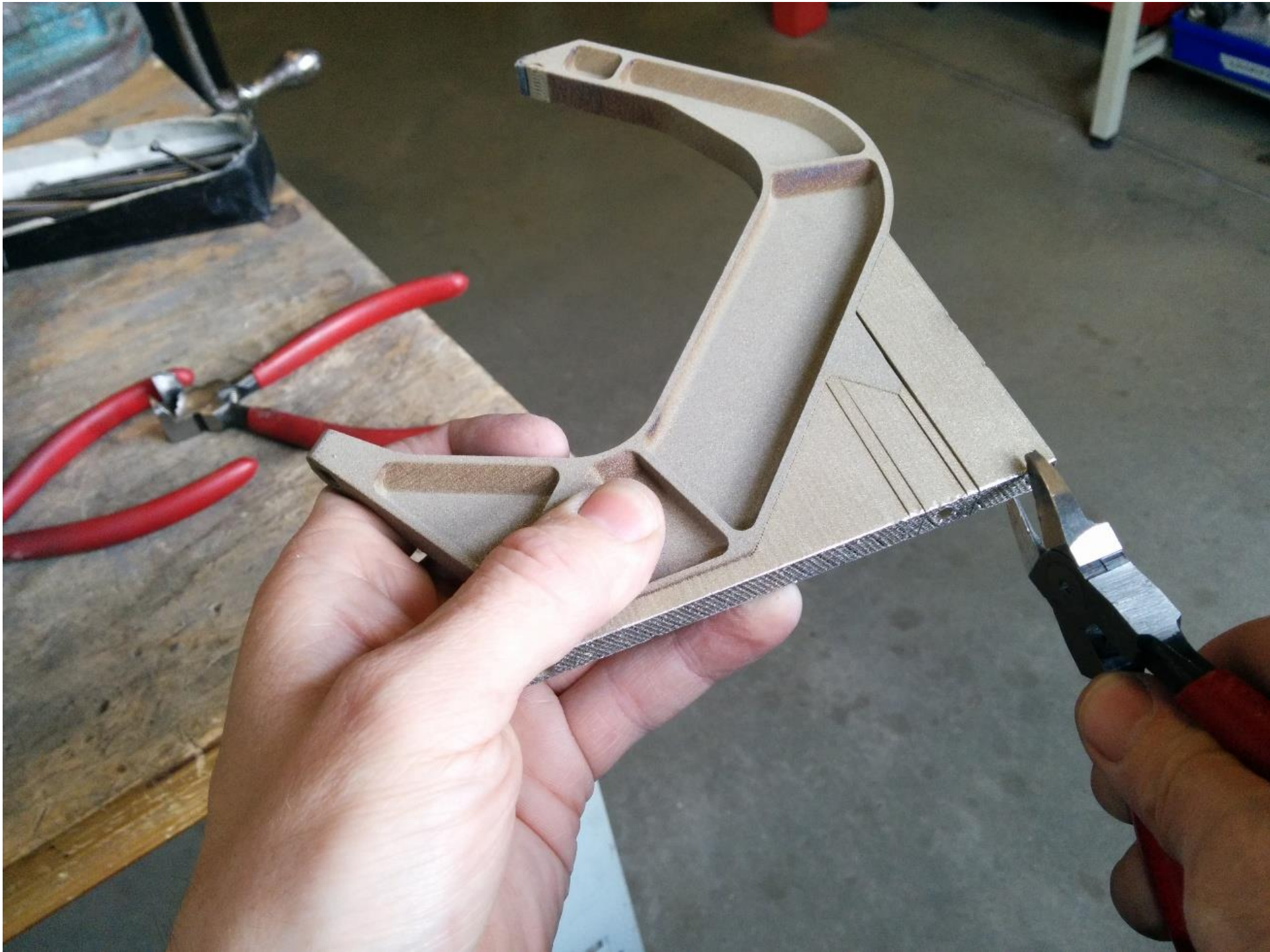
Typically 250mm x 250mm x 325mm

X line 1000R
capable of a total build of 630 mm x 400 mm x 500 mm.



11. What additional stages are required?

- Support and plattern removal
- Grit blasting?
- Stress relieving?
- Final machining of critical surfaces
- Polishing



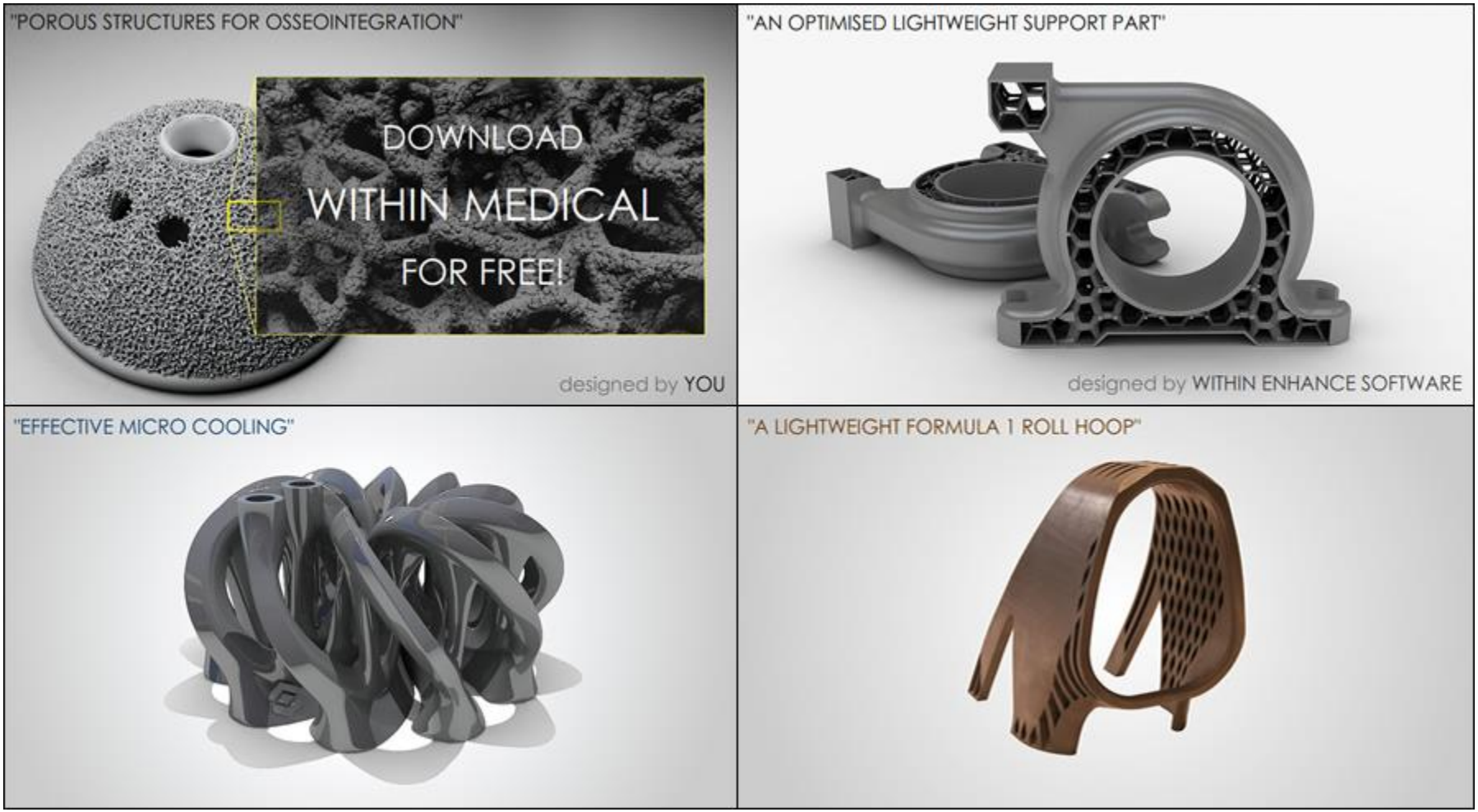

NSK
35
ON/OFF
HAND
FWD
FOOT
POWER
REV
A
B

12. Issues?

- Powder reuse
- Software
- Designers – Constrained thinking?
- Inspection
- Internal stresses
- Copper and Silver

WITHIN

Software – Optimisation



13. Future?

AMAZE

€ 20 Million European Commission Project: Additive Manufacturing Aiming Towards Zero Waste & Efficient Production of High-Tech Metal Products

The overarching goal of AMAZE is to rapidly produce large defect-free additively-manufactured (AM) metallic components up to 2 metres in size, ideally with close to zero waste, for use in the following high-tech sectors namely: aeronautics, space, nuclear fusion, automotive and tooling.

- Argentium silver (95.8% Ag, Cu and Germanium)
- Professor Mark Stanford (Professor of Advanced Manufacturing Technology, University of Wolverhampton)

14. What is this?